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JAPAN PATENT OFFICE

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[Title of Invention]	COOLING DEVICE FOR HEAT GENERATING ELEMENT AND ELECTRONIC DEVICE
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[NAME OF THE DOCUMENT] SPECIFICATION

[TITLE OF THE INVENTION] COOLING DEVICE FOR HEAT PRODUCING ELEMENT AND ELECTRONIC DEVICE

[CLAIMS FOR A PATENT]

[CLAIM 1] A heat-producing-element cooling device, characterized by: comprising a first flow channel through which a cooling medium for cooling the heat producing element is capable of passing to the heat producing element or an element cooling portion thermally linked with the heat producing element, a second flow channel through which the cooling medium after passing through the heat producing element or the element cooling portion and being heated is capable of passing, and active heat transport means comprising a heat absorption portion and a heat production portion; and thermally linking the heat absorption portion with the first flow channel and further thermally linking the heat production portion with the second flow channel.

[CLAIM 2] The heat-producing-element cooling device as set forth in claim 1, characterized in that: the active heat transport means is a Peltier element; the heat absorption portion of the Peltier element is linked with the first flow channel directly or via a heat transfer member; and further the heat production portion of the Peltier element is linked with the second flow channel directly or via a heat transfer member.

[CLAIM 3] The heat-producing-element cooling device as set forth in claim 1 or 2, characterized by comprising the first flow channel, the second flow channel and the element cooling portion in a united manner.

[CLAIM 4] An electronic device provided with a first chassis and a second chassis as interposing a hinge portion and being open-and-closable, characterized by comprising: a first flow channel through which a cooling medium for cooling the heat producing element provided in the first chassis is capable of passing to the heat producing element or an element cooling portion thermally linked with the heat producing element; a second flow channel through which the cooling medium after passing through the heat producing element or the element cooling portion and being heated is capable of passing; active heat transport means comprising a heat absorption portion and a heat production portion; first thermal link means thermally linking the heat absorption portion with the first flow channel; second thermal link means thermally linking the heat production portion with the second flow channel; a heat radiation unit provided in the second chassis; and a pump for circulating the cooling medium within the heat radiation unit, the first flow channel, the second flow channel and the element cooling medium.

[DETAILED DESCRIPTION OF THE INVENTION]

[0001]

[Field of the Invention]

The present invention relates to a heat-producing-element cooling device for cooling a heat producing element such as a CPU and an electronic device provided with the heat-producing-element cooling device, and, more particularly relates to a heat-producing-device cooling device and an electronic device which are capable of effectively cooling the heat producing element with a reduced electricity

consumption.

[0002]

[PRIOR ART]

Hitherto, as schematically illustrated in Fig. 13, a notebook PC 101 as an example of electronic devices is constituted as being provided with a first chassis 103 and a second chassis 105 with interposing a hinge portion so as to be open-and-closable, and a substrate 113 comprising a battery 107, a PC card slot 109, a hard-disc drive 111 and a CPU (not shown) is disposed in the first chassis 103. Further, the second chassis 105 is in general constituted as a display portion.

[0003]

For cooling of heat producing members such as a heat producing element, a fan 115 is housed in and disposed at a rear side of the first chassis 103 and cooling of the interior of the first chassis 103 is accomplished by driving the fan 115 so as to exhaust air within the first chassis 103 and suck the air outside through the air-intake ports provided at plural parts on the first chassis 103.

[0004]

Therefore, in the aforementioned constitution, there exists a problem in terms of effective cooling of a heat producing element having great heat production, such as a CPU.

[0005]

Moreover, among the former electronic devices, there is a constitution in which a heat radiation module 117 comprising a fan 115 is disposed as shown in Fig. 14. The heat radiation module 117 has a constitution, as shown in Fig. 15, in which

a fin base 125 having plural cooling fins 123 is thermally linked via thermally conductive grease or a thermally conductive sheet with a semiconductor element 121 such as a CPU electrically linked with a socket 119 on a substrate 113. The fin base 125 is installed on a backup plate 127 reinforcing the substrate 113 by means of plural fixation screws 129. Further, the fin base 125 is formed as a duct structure by providing a lid 131 at the tip portions of the cooling fins 123 for promoting contact of the air flowing through gaps of the cooling fins 123 with the cooling fins 123 and effective thermal conduction from the cooling fins 123 to the air.

[0006]

In the aforementioned constitution, in a case where an amount of produced heat of the semiconductor element 121 comes to be greater, measures thereagainst can be taken by increasing an air flow rate, enlarging the cooling fins, increasing the number of the cooling fins so as to enlarge a heat conduction area, or changing the material of the cooling fins from an aluminum alloy to a copper alloy having a larger thermal conductivity.

[0007]

However, in accordance with the aforementioned measures, in a case of increasing the air flow rate, problems that noise comes to be large and a weight of the cooling fins is increased, which are led from increase in a load on the fan by increase in pressure drop of the air flowing through the gaps of the cooling fins, arise. As well, there may be a case where the cooling fins may not be enlarged because of limitation by a space for installation within the chassis and hence heat

radiation of the semiconductor element may not be efficiently accomplished.

[0008]

Therefore, as shown in Fig. 16, there is proposed a measure to interpose a Peltier element 133 between the semiconductor element 121 and the fin base 125 for promotion of the heat radiation of the semiconductor element 121. The Peltier element 133 is a plate-like shape and capable of cooling the semiconductor element 121 by conducting current thereto so as to let a side of the semiconductor element 121 to be a heat absorption portion and the other side of the fin base 125 to be a heat production portion.

[0009]

However, the Peltier element 133 has a low thermal conductivity between the front and rear sides in a state that the current is stopped, and exhausts electricity for itself to produce and radiate heat when the current flows, thereby an amount of heat radiating by the semiconductor element 121 and an amount of heat radiating by the Peltier element are accumulated and hence an amount of heat radiating by the cooling fins 123, which leads to a problem that the cooling fins 123 should be necessarily enlarged.

[0010]

In accordance with the notebook PC 101 as mentioned above, in a case where the second chassis 105 provided with the display portion is closed with respect to the first chassis 103, the first chassis 103 is covered with the second chassis 105 and heat radiation from the first chassis 103 may be obstructed thereby.

[0011]

Therefore, according to the notebook PC 101, as indicated in JPH10-254583, JPH09-145273, JPH11-340671 and JPH08-42983, there is a constitution in which the heat radiation unit is provided in the second chassis 105 and heat radiation is accomplished at the second chassis side.

[0012]

In the above constitution, as indicated in the prior examples, a heat pipe is used in the hinge portion in order to thermally linking between the heat acceptance unit at the first chassis 103 and the heat radiation unit or the hinge portion is constituted in a heat pipe constitution to which a flexible material is applied. In a case of the heat pipe, degradation in performance by occurrence of leakage comes to be considerable, therefore it is not preferable that the heat pipe is applied to the hinge portion or constituted in a flexible constitution.

[0013]

Moreover, as indicated in JPH07-142886, there is a constitution in which a cooling medium is driven by a pump and the hinge portion is spanned by a pipe of a flexible material. In accordance with this case, degradation in performance by occurrence of leakage is small, therefore it is preferable as compared with application of the heat pipe.

[0014]

Moreover, as schematically illustrated in Fig. 17, there is a constitution in which a heat acceptance unit 135 for cooling a heat producing element such as a CPU provided on a substrate 113 in a first chassis 103 is linked with a heat radiation

unit 137 provided at a second chassis 105 via a pipe path 139, further a pump 141 is linked with the heat radiation unit 137 via a pipe path 143, and the pump 141 is linked with the heat acceptance unit 135 via a pipe path 145.

[0015]

Inside of the heat acceptance unit 135, plural fins 147 is provided so as to enlarge a heat conduction area with respect to a proper cooling medium, for example, water, antifreeze or fluorocarbon.

[0016]

In the above constitution, the cooling medium flowing into the heat acceptance unit 135 by operation of the pump 141 cools the heat producing element and is hence heated and further flows into the heat radiation unit 137 to radiate heat and be cooled at the heat radiation unit 137. The cooled cooling medium again is circulated so as to flow into the heat acceptance unit 135 by operation of the pump 141.

[0017]

In the above constitution, the second chassis 105 is used as a heat radiation portion and thereby the heat radiation is effectively accomplished. By the way, in accordance with the above constitution, to improve performance of the heat acceptance unit 135 corresponding to increase in an amount of the heat producing by the heat producing element, a measure can be taken by miniaturizing the fins 147 in the heat acceptance unit 135. However, in this case, it likely brings about pressure loss of the cooling medium flowing in the heat acceptance unit 135, though a heat conduction area is increased by miniaturizing the fins and it can be expected to increase

a thermal conductivity by miniaturizing.

[0018]

Therefore, it is possible to enlarge the pump 141, however, enlargement is difficult in view of a limited space of the first chassis 103. Moreover, it is possible to enlarge the heat acceptance unit 135 itself, however, enlargement is also difficult in view of the limited space.

[0019]

[PROBLEMS TO BE SOLVED BY THE INVENTION]

More specifically, in the former constitutions, for example when cooling a heat producing element such as a CPU, in a case where heat radiation of the heat producing element is accomplished by cooling fins, if heat producing rate of the CPU gets larger, a problem that enlargement of the cooling fins is difficult in view of a limited space arise. Moreover, if effective cooling is intended by interposing a Peltier element between the cooling fins and the heat producing element, the heat production of the Peltier element in itself becomes problematic and gives rise to a problem that the cooling fins must be enlarged as compared with the heat production rate of the heat producing element.

[0020]

Furthermore, in the constitution in which the cooling medium is circulated in the system for cooling the heat producing element, if the heat production rate of the heat producing element increases, a problem that the heat acceptance unit which accept heat from the heat producing element must be enlarged arises.

[0021]

[MEANS FOR SOLVING THE PROBLEMS]

The present invention has been achieved in view of the above problems and the invention related to claim 1 has a constitution in which a first flow channel through which a cooling medium for cooling the heat producing element is capable of passing to the heat producing element or an element cooling portion thermally linked with the heat producing element, a second flow channel through which the cooling medium after passing through the heat producing element or the element cooling portion and being heated is capable of passing, and active heat transport means comprising a heat absorption portion and a heat production portion are provided; the heat absorption portion is thermally linked with the first flow channel; and the heat production portion is thermally linked with the second flow channel.

[0022]

The invention related to claim 2 has a constitution in which, in combination with the cooling device as set forth in claim 1, the active heat transport means is a Peltier element; the heat absorption portion of the Peltier element is linked with the first flow channel directly or via a heat transfer member; and further the heat production portion of the Peltier element is linked with the second flow channel directly or via a heat transfer member.

[0023]

The invention related to claim 3 has a constitution in which, in combination with the cooling device as set forth in claim 1 or 2, the first flow channel, the second flow channel and the element cooling portion are provided in a united manner.

[0024]

The invention related to claim 4 has a constitution in which, in combination with an electronic device provided with a first chassis and a second chassis as interposing a hinge portion and being open-and-closable, a first flow channel through which a cooling medium for cooling the heat producing element provided in the first chassis is capable of passing to the heat producing element or an element cooling portion thermally linked with the heat producing element; a second flow channel through which the cooling medium after passing through the heat producing element or the element cooling portion and being heated is capable of passing; active heat transport means comprising a heat absorption portion and a heat production portion; first thermal link means thermally linking the heat absorption portion with the first flow channel; second thermal link means thermally linking the heat production portion with the second flow channel; a heat radiation unit provided in the second chassis; and a pump for circulating the cooling medium within the heat radiation unit, the first flow channel, the second flow channel and the element cooling medium are provided.

[0025]

[EMBODIMENTS FOR CARRYING OUT THE INVENTION]

Referring to Fig. 1, a heat-producing-element cooling device 1 according to a first embodiment is installed on a substrate 3 provided in an electronic device (the whole constitution thereof is not shown) similar to the aforementioned former notebook PC and thermally linked with a semiconductor element (heat producing element) 7 such as

a CPU electrically linked a socket 5 provided on the substrate 3.

[0026]

More specifically, the heat-producing-element cooling device 1 is formed by being provided with a sealed thin box-shape casing 9 and inside of the casing 9 is partitioned into a coolant cooling chamber (coolant cooling portion) 11 as a first flow channel, through which a cooling medium, for example, water, antifreeze or fluorocarbon, is capable of passing, an element cooling chamber (element cooling portion) 13 for cooling the heat producing element 7, and a coolant heating chamber (coolant heating portion) 15 as a second flow channel, through which the cooling medium after passing through the heat producing element or the element cooling portion and being heated is capable of passing, by a partition wall 17 which is substantially shaped in a T-letter shape. In other words, the coolant cooling chamber 11, the element cooling chamber 13 and the coolant heating chamber 15 are provided in one piece of the casing 9 so as to be unitized as a heat acceptance unit 9U.

[0027]

The coolant cooling chamber 11 is provided with an inflow port 19 and, in the coolant cooling chamber 11, a plurality of thin-plate shaped fins 21 are arranged in parallel with a flow direction of the cooling medium. The shape of the fins 21 are not limited as a thin-plate but may be pin-like shaped or omitted properly depending on cases.

[0028]

The coolant heating chamber 15 has a constitution symmetrically with the coolant cooling chamber 11 and, in the

coolant heating chamber 15, fins 21 are disposed and an outflow port 23 for the cooling medium are provided. A slit 25 as heat insulation means is formed in the partition wall 17 between the coolant cooling chamber 11 and the coolant heating chamber 15 and a heat insulator 27 is provided in the slit 25.

[0029]

The coolant cooling chamber 11 communicates with the element cooling chamber 13 via a communication hole 29 and the element cooling chamber 13 similarly communicates with the coolant heating chamber 15 via a communication hole 29. Further, also in the element cooling chamber 13, as similar to the coolant cooling chamber 11, a plurality of fins 21 are arranged in parallel with a flow direction of the cooling medium.

[0030]

A Peltier element 31 as an example of active heat transport means is installed on the lower side (rear side) of the casing 9 at a position corresponding to the coolant cooling chamber 11, namely at the lower side of the coolant cooling chamber 11. The Peltier element 31 is an element functioning so that the upper side thereof comes to be a heat intake portion and the lower side comes to be a heat outlet portion at a time of turning on electricity.

[0031]

For accomplishing heat transfer from the Peltier element 31 to the coolant heating chamber 15, a proper heat transfer member 33 made of a plate-like heat pipe, thermally conductive metal or carbon fiber such as copper or aluminum is provided as a thermal bypass between the lower side of the Peltier element 31 and the lower side of the coolant heating chamber 15. More

specifically, the heat outlet portion of the Peltier element 31 is thermally linked with the coolant heating chamber 15.

[0032]

The casing 9 is provided with brackets 35 at plural positions thereof. The casing 9 is fixed with a backing plate 39 which reinforces the substrate 3 on the substrate 3 by means of installation screws 37 penetrating installation holes 35H provided on the respective brackets 35. As installed on the casing 9 in such a way, the lower side of the element cooling chamber 13 is in contact with and thermally linked with the upper side of the heat producing element 7.

[0033]

By the aforementioned constitution, when the cooling medium flows into the coolant cooling chamber 11 through the inflow port 19 by a pump (not shown), because the upper side of the Peltier element 31 is made to be a heat intake portion by turning electricity, the cooling medium is cooled in the coolant cooling chamber 11. Further, the cooled cooling medium flows into the element cooling chamber 13 and cools the heat producing element 7 by heat transfer.

[0034]

As mentioned above, the cooling medium after cooling the heat producing element 7 next flows into the coolant heating chamber 15. Heat of the heat outlet portion of the Peltier element 31 is conducted to the coolant heating chamber 15 via the heat transfer member 33 and hence the coolant heating chamber 15 is in a heated state. Therefore the cooling medium in the coolant heating chamber 15 is further heated to a higher temperature to flow out of the outflow port 23. In other words,

the heat outlet portion of the Peltier element 31 is cooled via the heat transfer member 33 and the coolant heating chamber 15.

[0035]

The cooling medium flowing out of the outflow port 23 is cooled by being subject to heat radiation at, for example, a heat radiation unit 41 (see Fig. 2). The cooling medium comes to be supplied to the coolant cooling chamber 11 of the heat acceptance unit 9U to circulate by the pump 41.

[0036]

The aforementioned constitution can be block-diagrammed as shown in Fig. 2. A characteristic of the Peltier element 31 when a temperature difference between the heat outlet portion and the heat intake portion of the Peltier element 31 as the active heat transport element is constant is illustrated as shown in Fig. 3. As being understood from Fig. 3, the greater the heat absorption rate, the greater the ratio of exhausted heat to absorbed heat (exhausted heat/absorbed heat) as in a quadric curve. More specifically, the greater the heat absorption rate, the lesser the efficiency of the Peltier element 31.

[0037]

Therefore, in the aforementioned former constitution shown in Fig. 16 in which the heat producing element and the heat intake portion of the Peltier element are thermally linked, the heat produced by the heat producing element must be completely absorbed by the Peltier element and radiated, thereby the efficiency of the Peltier element is decreased. Supposing that heat produced by the CPU 7 which produces 20

W of heat is completely absorbed, as apparently from Fig. 3, heat quantity having two times greater value of the exhausted heat/the absorbed heat is necessary to be cooled at the heat acceptance unit, thereby a load to the heat acceptance unit comes to be heavy.

[0038]

However, as shown in Fig. 2, for example in a case where 10 W of heat is transported from the Peltier element 31 to the heat radiation unit 41 via the heat transfer member 33, the value of exhausted heat/absorbed heat of the Peltier element 31 increases by about 30 % as apparently from Fig. 3, more specifically, 30 W increase in the amount of produced heat will meet a demand and the load to the heat acceptance unit 9U can be reduced. Here, since the cooling medium flowing into the element cooling chamber 13 of the heat acceptance unit 9U has decreased in temperature by being absorbed of 10 W of heat by the Peltier element 31, the heat acceptance unit 9U is only necessary to have 10 W of heat radiation capacity, which is left by a deduction of 10 W from 20 W of the produced heat of the heat producing element 7. More specifically, the load to the heat acceptance unit can be decreased to 1/2 with increase in electric power (3 W) corresponding to 15 % of heat production rate of the heat producing element 7 as compared with a case where whole of the produced heat of the heat producing element 7 is subject to heat radiation, and hence it is considerably advantageous in a constitution in which, for example, it is disposed in a compact chassis such as a notebook PC which has a limited installation space for installation of an electronic device.

[0039]

Fig. 4 shows a second embodiment. Substantially the same constituent elements as the aforementioned constitution are referred with the same reference numerals and detailed descriptions are omitted. According to this second embodiment, a coolant cooling chamber 11 and a coolant heating chamber 15 are adjacently provided as a unit and an element cooling chamber 13 is separated therefrom. Therefore, the coolant cooling chamber 11 and the coolant heating chamber 15 are respectively provided with communication holes 29A so as to be communicated with the element cooling chamber via pipes.

[0040]

In accordance with the aforementioned constitution, freedom of disposition of the element cooling chamber 13 increases since the element cooling chamber 13 is separated from the unit of the coolant cooling chamber 11 and the coolant heating chamber 15.

[0041]

Fig. 5 shows a third embodiment. Substantially the same constituent elements as the aforementioned constitutions are referred with the same reference numerals and detailed descriptions are omitted. According to this third embodiment, the Peltier element 31 illustrated in Fig. 4 is disposed between the coolant cooling chamber 11 and the coolant heating chamber 15 so as to thermally link therewith. More specifically, the coolant cooling chamber 11 and the coolant heating chamber 15 directly sandwich the Peltier element 31.

[0042]

In accordance with the aforementioned constitution, the

heat transfer member 33 can be omitted and hence the constitution can be simplified, as well as the heat conduction is directly accomplished so that the efficiency is increased.

[0043]

Fig. 6 shows a fourth embodiment, in which air is employed to the cooling medium.

[0044]

More specifically, a fin base 47B provided with a plurality of fins 47 is in contact with and thermally linked with the CPU 7 electrically linked with a socket 5 provided on the substrate 3 housed in the main chassis 45 of the electronic device. A Peltier element 31 is disposed at a position close to an air intake port 53 which sucks air outside by rotating a fan 49 provided in the main chassis 45 and an air exhaust port 55 which exhausts the air by rotation of the fan 49.

[0045]

A fin base 59B having a plurality of fins 59 disposed inside of an inflow path 57 as a first flow path through which air flows from the air intake port 53 toward the heat producing element 7 is thermally linked with the heat intake portion of the Peltier element 31. Moreover, a fin base 63B having a plurality of fins 63 disposed inside of an exhaust path 61 as a second flow path through which air flows via the fins 47 to the air exhaust port 57 is thermally linked with the heat outlet portion of the Peltier element 31.

[0046]

Therefore, in the aforementioned constitution, when the fan 49 is driven, air is sucked from the air intake port 53 and the sucked air is cooled by the fins 59. The cooled air

flows to the side of the heat producing element 7 and cools the heat producing element 7 and the socket 5 to flow into the duct 51. And, when the air passes through the part of the fins 47, the air cools the fins 47 and, after that, is exhausted outward from the air exhaust port 55.

[0047]

In accordance with the aforementioned constitution, the air cooled by the Peltier element 31 directly cools the heat producing element 7 and further cools the fins 47 at a state of being heated by heat conduction from the heat producing element 7, thereby cooling of the heat producing element 7 can be effectively accomplished.

[0048]

Fig. 7 shows an embodiment in which the aforementioned heat-producing-element cooling device is applied to a notebook PC 65 as an example of the electronic device.

[0049]

In the notebook PC 65, substantially the same constituent elements as the aforementioned former notebook PC 101 are referred with the same reference numerals and detailed descriptions are omitted.

[0050]

In accordance with the notebook PC 65, the notebook PC 65 is provided with a heat acceptance area 67 as well as an auxiliary heat radiation unit 69 having a coolant cooling chamber 11 (not shown in Fig. 7) and a coolant heating chamber 15 (not shown) are disposed in the first chassis 103. Further, a heat radiation unit 41 disposed in the second chassis 105 and the auxiliary heat radiation unit 69 are linked with each

other via a pipe line 70, and a pump 43 for circulating the cooling medium between the heat radiation unit 41 and the auxiliary heat radiation unit 69 is disposed in the first chassis 103.

[0051]

In the auxiliary heat radiation unit 69, the heat acceptance area 69 corresponding to the element cooling chamber 13 is, as shown in Fig. 8, provided with an inlet port 67A for the cooling medium as similar to the element cooling chamber 13 and an outlet port 67B, and further provided with a plurality of fins 67C in the internal space. The heat acceptance area 67 is thermally linked with the heat producing element 7 such as a CPU (not shown in Fig. 7) installed on a substrate 113.

[0052]

Heat radiation portions provided on the heat radiation unit 41 and the auxiliary heat radiation unit 69 have, as shown in Fig. 9, a constitution in which a plane sheet 71A and a wave-like formed sheet 71B are combined so as to have a plurality of flow paths 71C.

[0053]

Meanwhile, temperature sensors 73A and 73B (see Fig. 7) are respectively provided at portions of the heat radiation unit 41 and the heat acceptance area 67.

[0054]

By the aforementioned constitution, as described with reference to Fig. 2, the cooling medium circulates by driving the pump 43 so that cooling of the heat producing element is accomplished at the heat acceptance area 67. And, though heat radiation of the cooling medium heated by cooling the heat

producing element is accomplished at the auxiliary heat radiation unit 69 and the heat radiation unit 41, the heat radiation is mainly accomplished at the heat radiation unit 41. The cooling medium cooled by the heat radiation is circulated again to the heat acceptance area 67 by driving the pump 43.

[0055]

At a time of cooling the heat producing element by circulating the cooling medium as mentioned above, temperatures of the heat radiation unit 41 and the auxiliary heat radiation unit 69 are detected by the sensors 73A and 73B and, in a case where there is a possibility of giving discomfortable feeling a low-temperature skin burn to the user, it can be operated so as to reduce a CPU clock to suppress the heat producing rate.

[0056]

Fig. 10 is those which a constitution of the pipe line linking the heat radiation unit 41 with the auxiliary heat radiation unit 69 is changed to a pipe line hinge 75 in the notebook PC 65.

[0057]

More specifically, as shown in Fig. 10(B), the pipe line of the auxiliary heat radiation unit 69 is made to be a large-sized pipe 75A and the pipe line of the heat radiation unit 41 is made to be a small-sized pipe 75B capable of being inserted into the pipe 75A from one side. Therefore, the hinge portion simultaneously serves as a pipe line for the cooling medium and an appearance comes to be better.

[0058]

By the way, in a case where the coolant cooling chamber 11 is disposed adjacent to the coolant heating chamber 15, heat conduction isolation portion 77 such as a slit should be preferably formed between the cooling chamber 11 and the coolant heating chamber 15 as shown in Fig. 11. In such a way, heat conduction between the coolant cooling chamber 11 and the coolant heating chamber 15 is prevented by forming the heat conduction isolation portion 77.

[0059]

Fig. 12 shows a heat radiation unit 41 and, in Fig. 12(A), those has a constitution in which a transparent pipe 79 is disposed at a part of an inflow side of the cooling medium and a lighting unit 81 provided with a LED illuminates the transparent pipe 79. Moreover, in Fig. 12(B), a U-letter-shaped transparent pipe 83 and a lighting unit 85 are disposed at a center part of the heat radiation unit 41.

[0060]

According to the above constitution, circulation of the cooling medium in the transparent pipes 79 and 83 can be checked, and the appearance in terms of design is improved.

[0061]

[EFFECT OF THE INVENTION]

As being understood from the above descriptions, according to the present invention, even though constituted so as to use for example the Peltier element to cool the heat producing element, the heat producing element can be effectively cooled without decrease in efficiency of the Peltier element.

[BRIEF DESCRIPTION OF DRAWINGS]

[FIG. 1]

Fig. 1 is a descriptive drawing of a heat-producing-element cooling device according to an embodiment of the invention.

[FIG. 2]

Fig. 2 is a descriptive drawing for a function of the heat-producing-element cooling device, which is shown as a block-diagram.

[FIG. 3]

Fig. 3 is a descriptive drawing of a characteristic of a Peltier element.

[FIG. 4]

Fig. 4 is a descriptive drawing indicating a second embodiment.

[FIG. 5]

Fig. 5 is a descriptive drawing indicating a third embodiment.

[FIG. 6]

Fig. 6 is a descriptive drawing indicating a fourth embodiment.

[FIG. 7]

Fig. 7 is a schematically descriptive drawing of a notebook PC.

[FIG. 8]

Fig. 8 is a descriptive drawing of a heat acceptance area.

[FIG. 9]

Fig. 9 is a cross sectional descriptive drawing of a hear radiation unit.

[FIG. 10]

Fig. 10 is a descriptive drawing schematically showing a notebook PC.

[FIG. 11]

Fig. 11 is a descriptive drawing showing a constitution in which a coolant cooling chamber and a coolant heating chamber are formed in an auxiliary heat radiation unit.

[FIG. 12]

Fig. 12 is a descriptive drawing of a heat radiation plate.

[FIG. 13]

Fig. 13 is a descriptive drawing schematically showing a former notebook PC.

[FIG. 14]

Fig. 14 is a descriptive drawing schematically showing a former notebook PC.

[FIG. 15]

Fig. 15 is a descriptive drawing of a constitution of a former heat radiation module.

[FIG. 16]

Fig. 16 is a descriptive drawing of a constitution of a former heat radiation module.

[FIG. 17]

Fig. 17 is a descriptive drawing schematically showing a cooling medium system of a former notebook PC.

[DESCRIPTION OF THE REFERENCE NUMERALS]

1 heat-producing-element cooling device

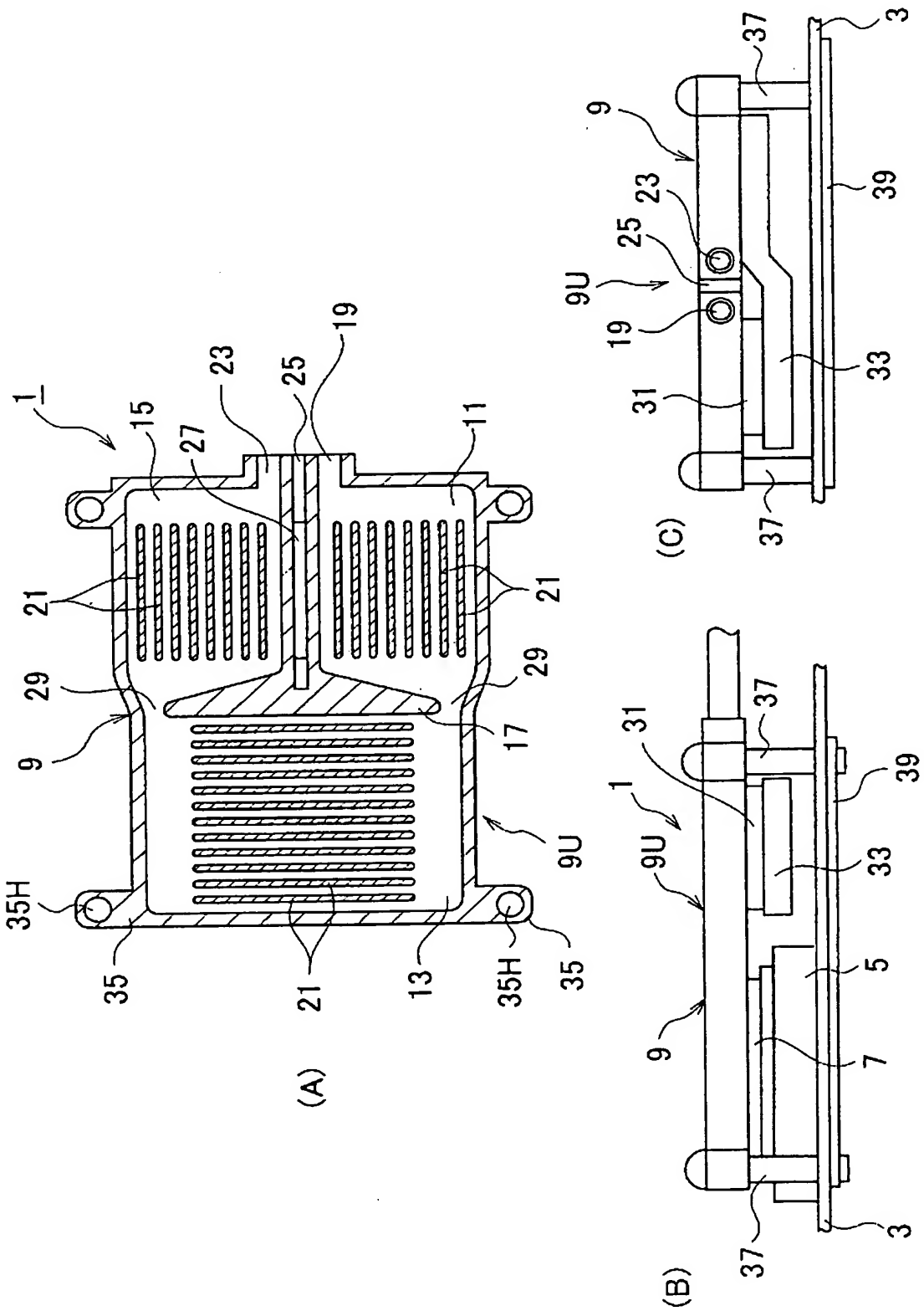
7 semiconductor element (heat producing element)

9 casing

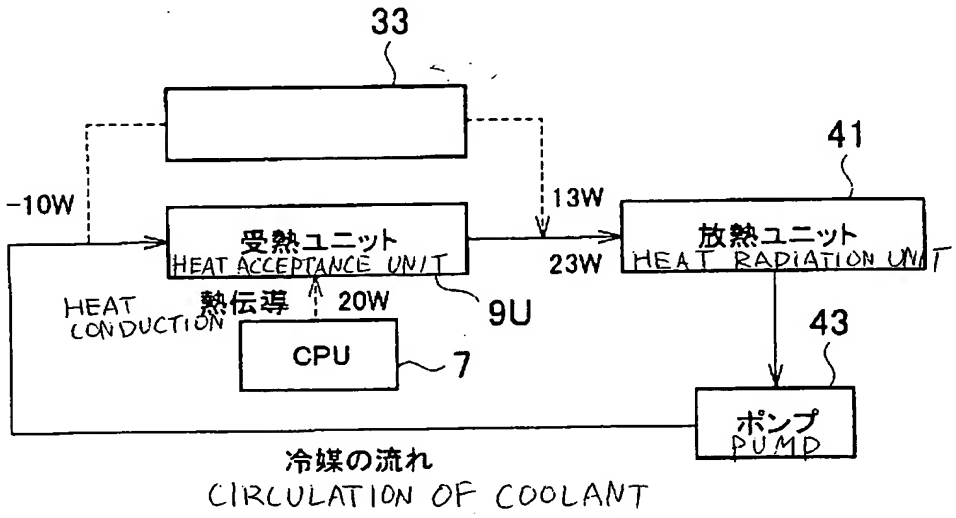
9U	heat acceptance unit
11	coolant cooling chamber
13	element cooling chamber
15	coolant heating chamber
19	inflow port
21	fin
23	outflow port
31	Peltier element (active heat transport element)
33	heat transfer memeber
41	heat radiation unit
43	pump
45	chassis
53	air intake port
55	air exhaust port
57	inflow path
59	fin
61	exhaust path
63	fin
67	heat acceptance area
69	auxiliary heat radiation unit

【書類名】　図面　[NAME OF THE DOCUMENT]　DRAWINGS

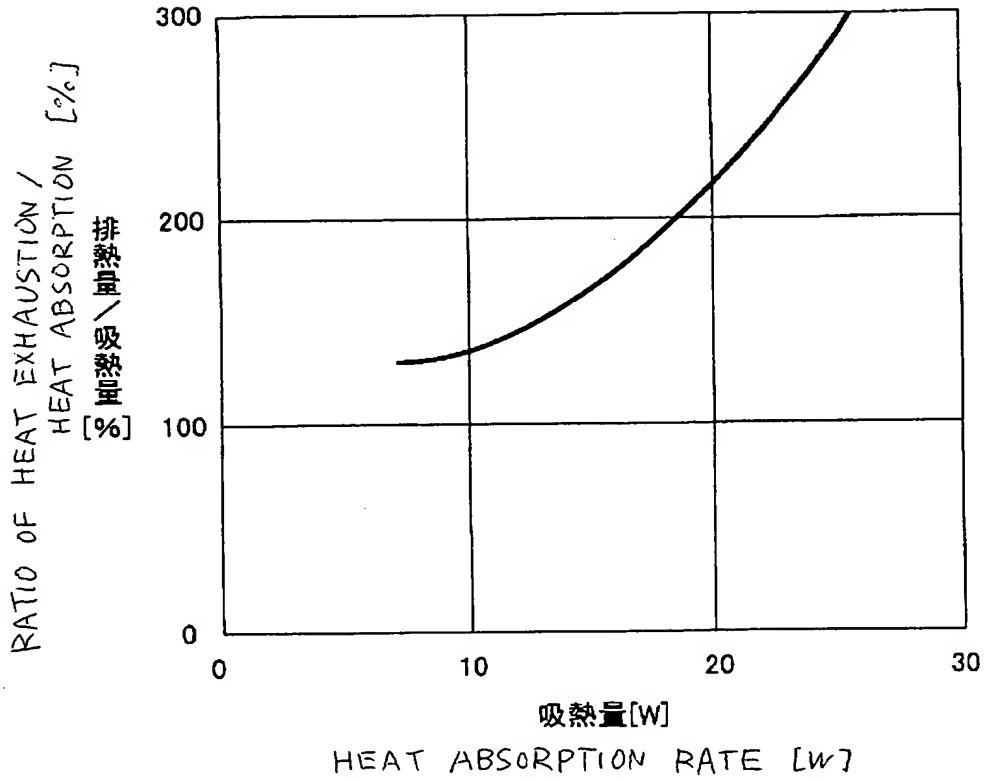
【図１】 [FIG. 1]



【図２】〔FIG.2〕

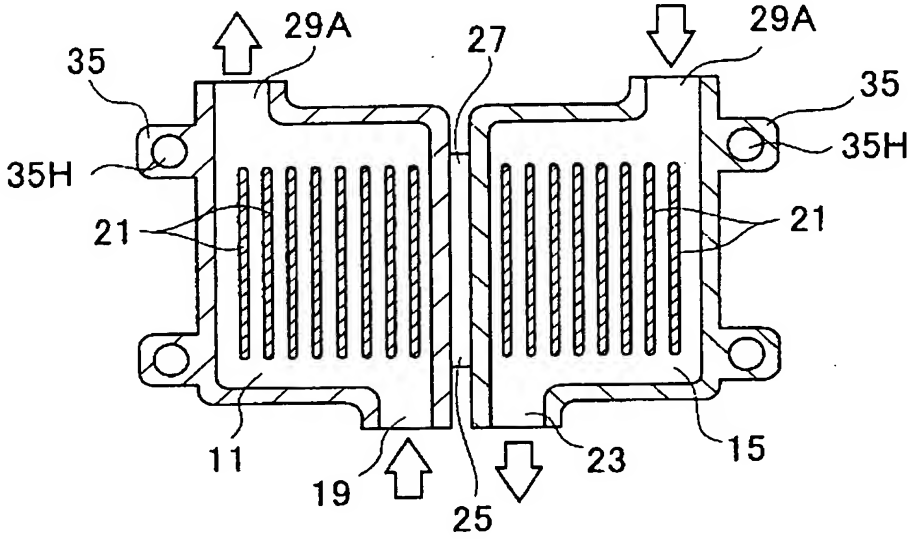

33
41
-10W
13W
受熱ユニット
HEAT ACCEPTANCE UNIT
23W
放熱ユニット
HEAT RADIATION UNIT
HEAT CONDUCTION
熱伝導
20W
9U
CPU
7
43
ポンプ
PUMP
冷媒の流れ
CIRCULATION OF COOLANT

【図３】

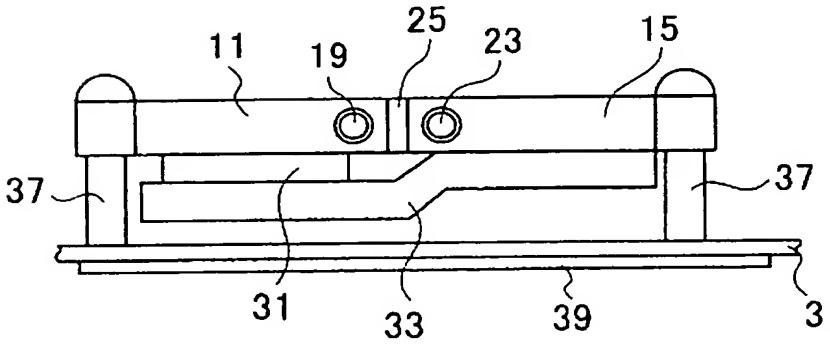

RATIO OF HEAT EXHAUSTION / HEAT ABSORPTION [%]
排熱量／吸熱量
[%]
300
200
100
0
0
10
20
30
吸熱量[W]
HEAT ABSORPTION RATE [W]

【図４】[FIG.4]

(A)

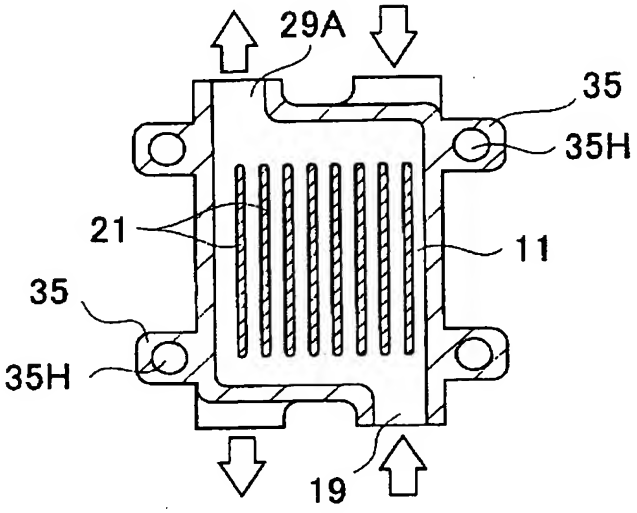

29A
27
29A
35
35
35H
35H
21
21
11
19
25
23
15

(B)

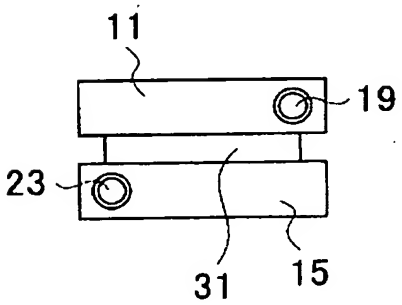

11
19
25
23
15
37
37
31
33
39
3

【図５】[FIG.5]

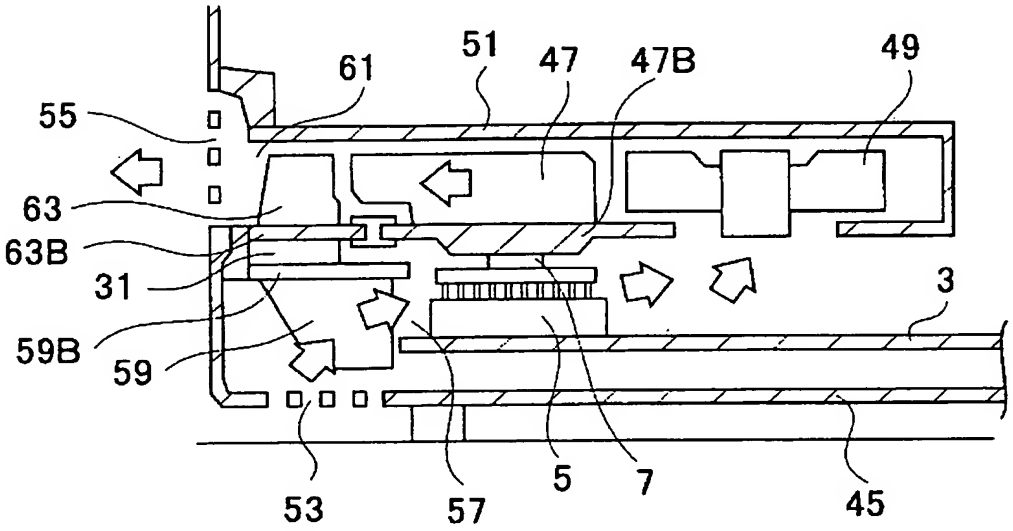
(A)



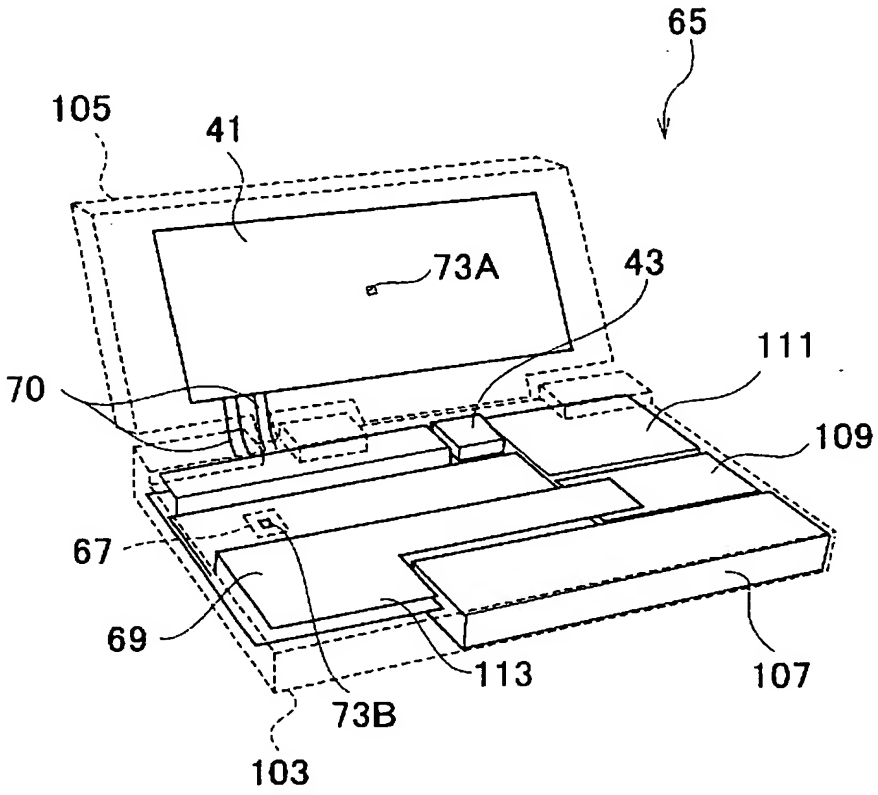
(B)



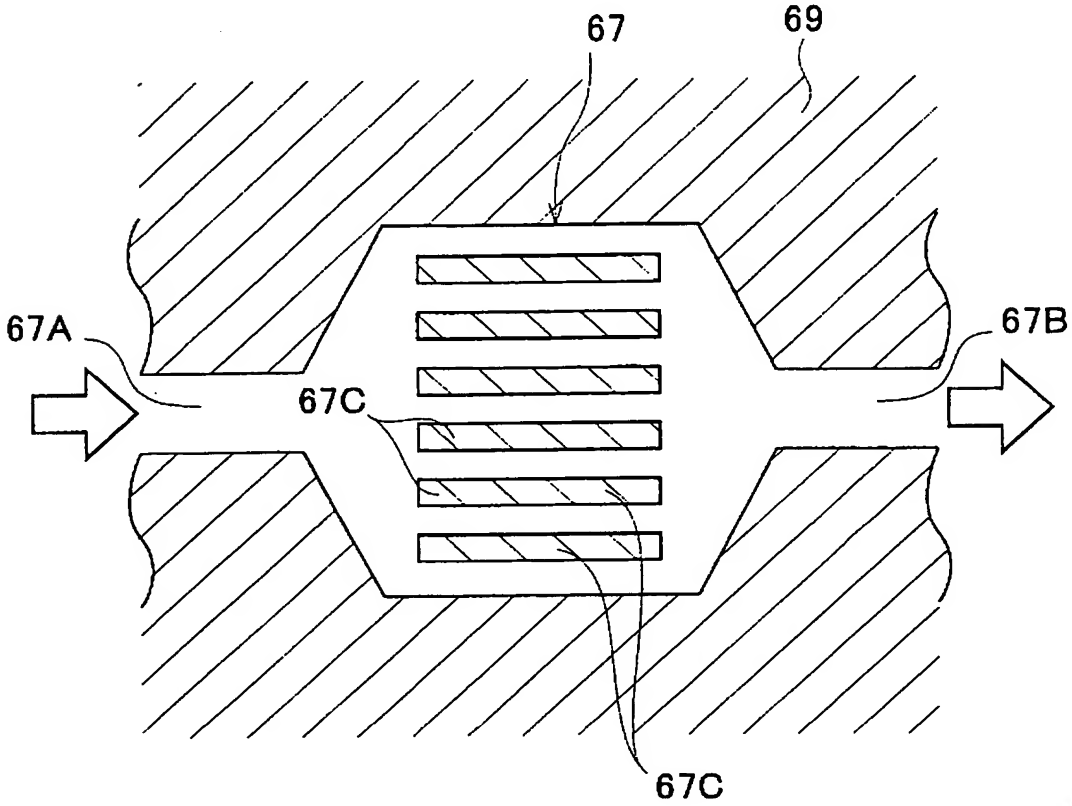
【図６】 [FIG.6]



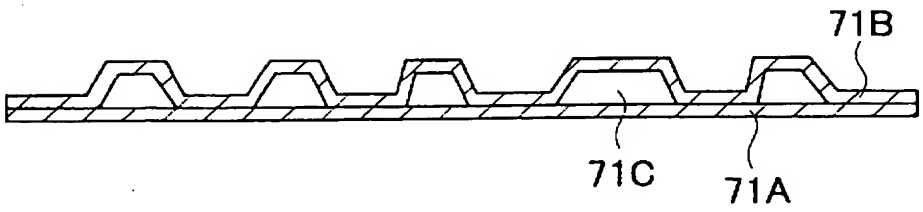
【図７】[FIG.7]



【図８】［FIG.8］

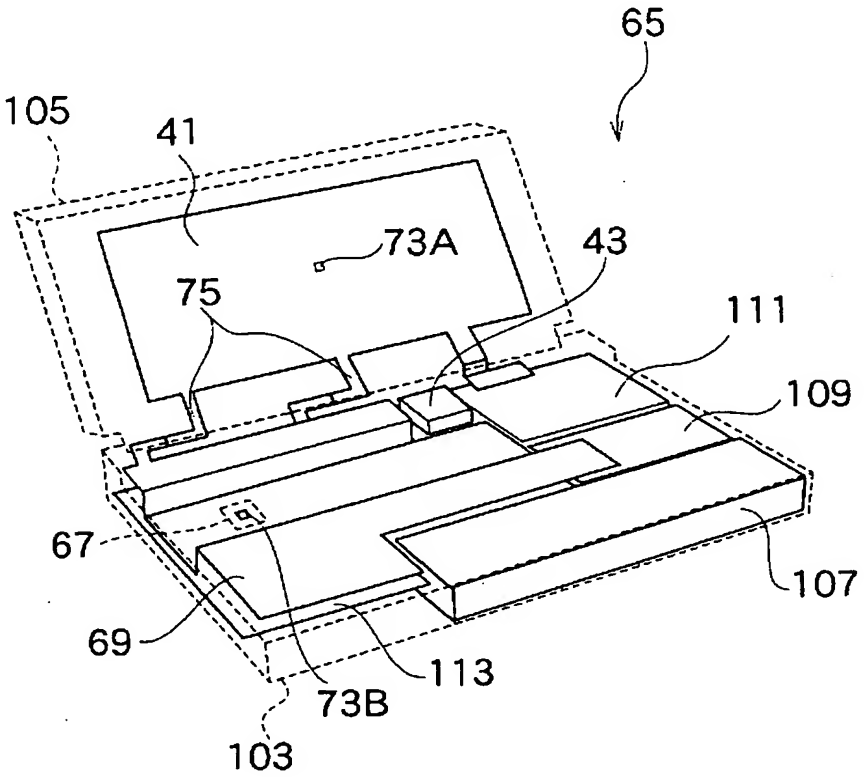


【図９】［FIG.9］

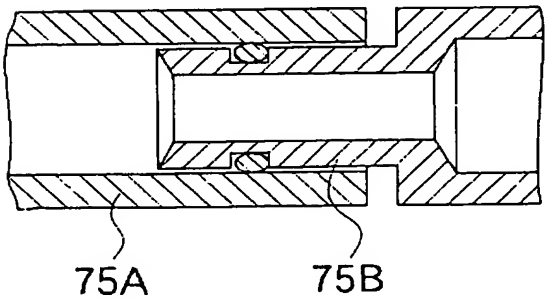


【図１０】 [FIG.10]

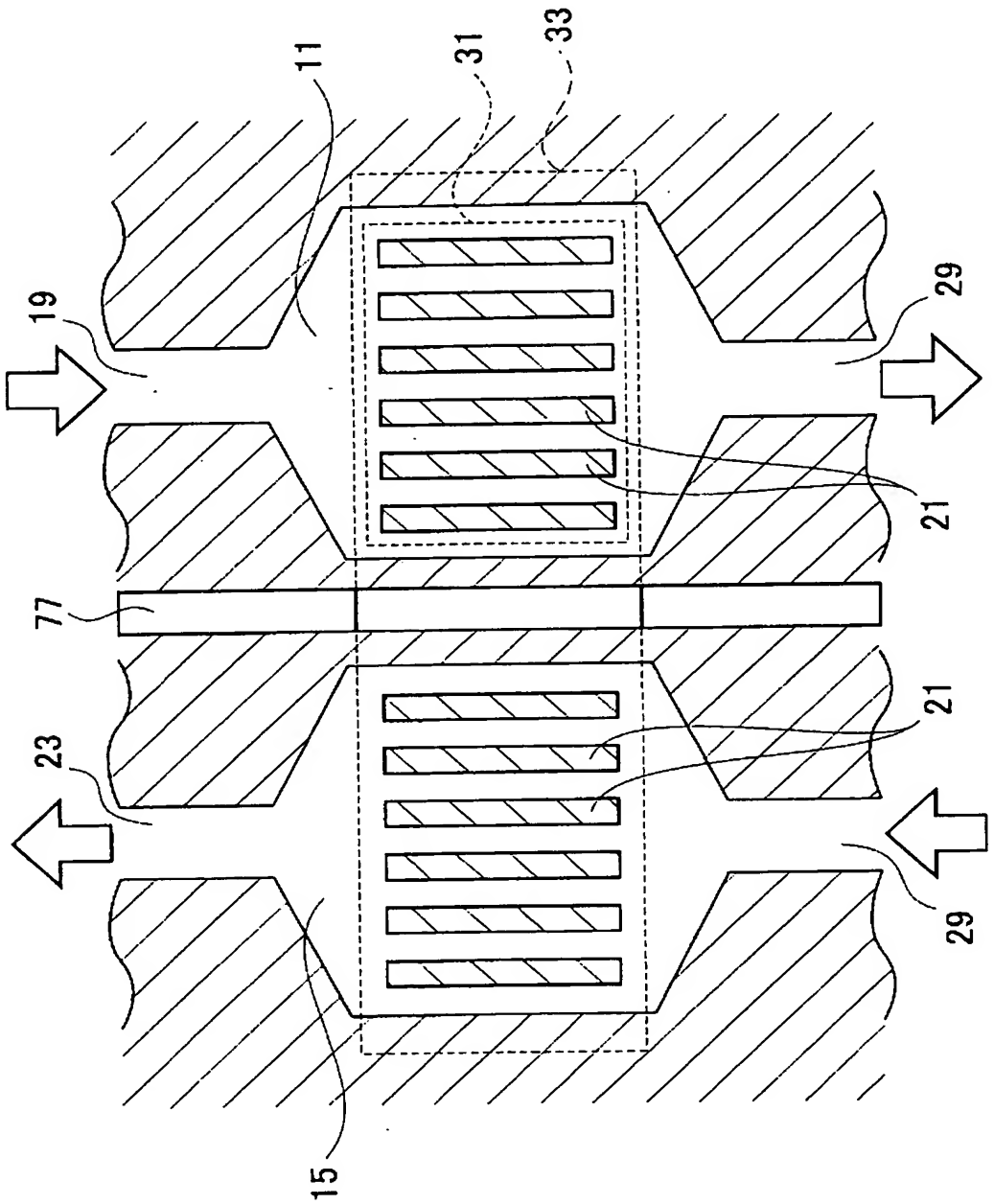
(A)



(B)

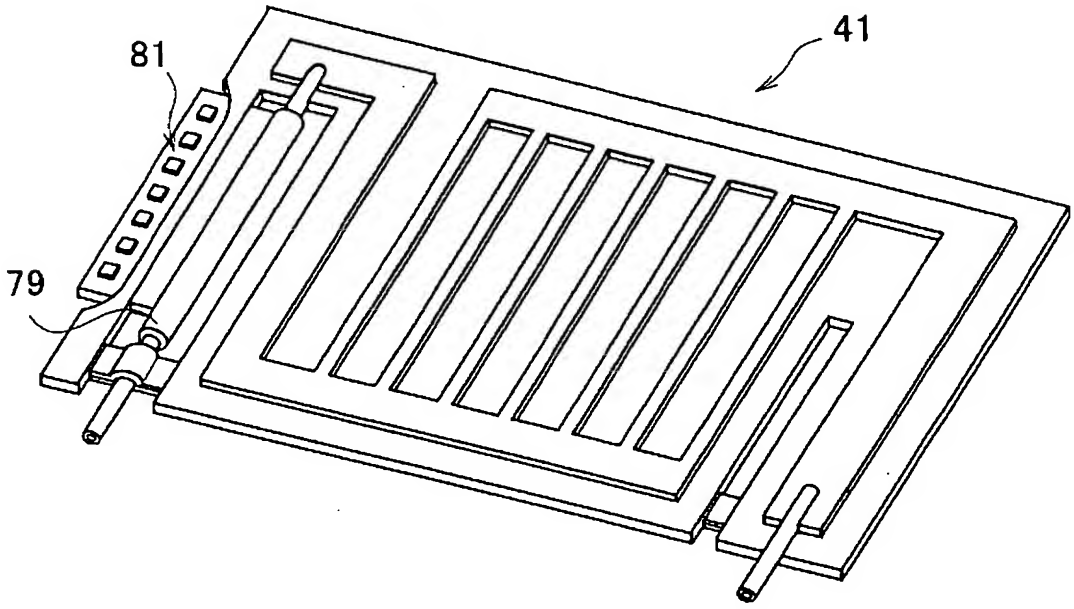


【図１１】 [FIG. 11]

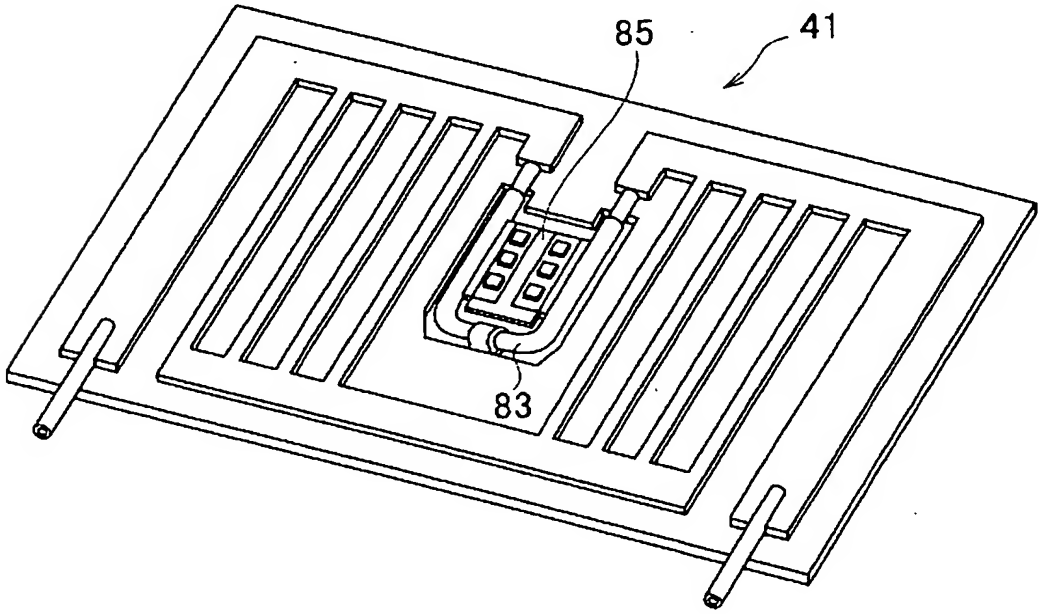


【図１２】 [FIG. 12]

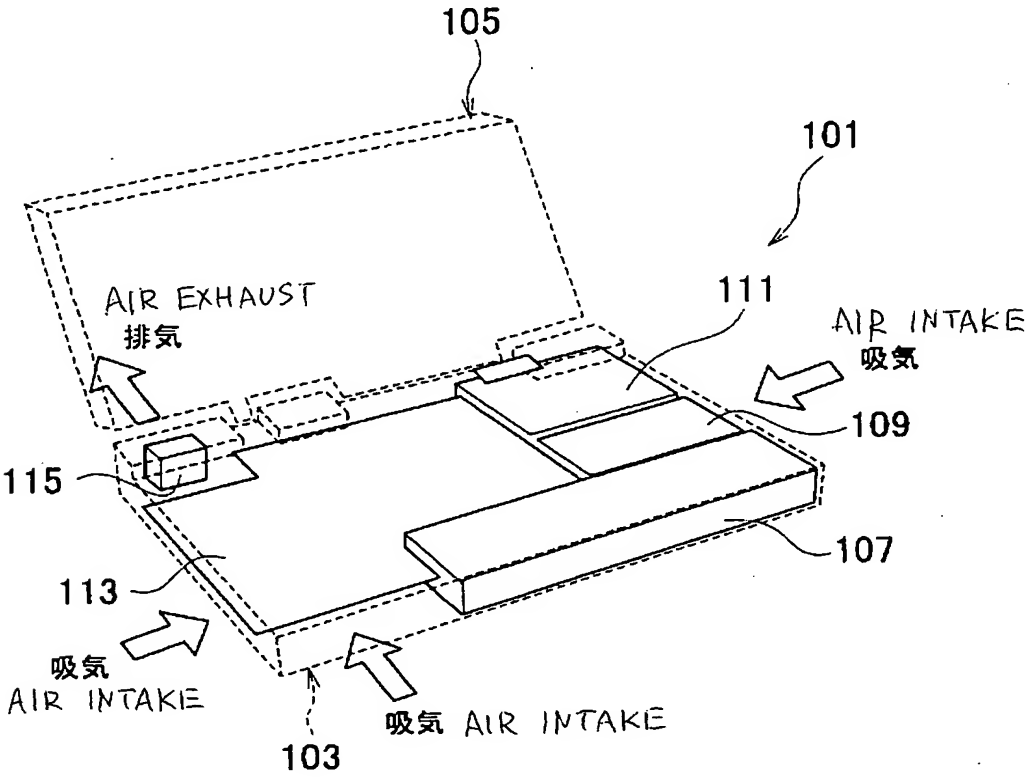
(A)



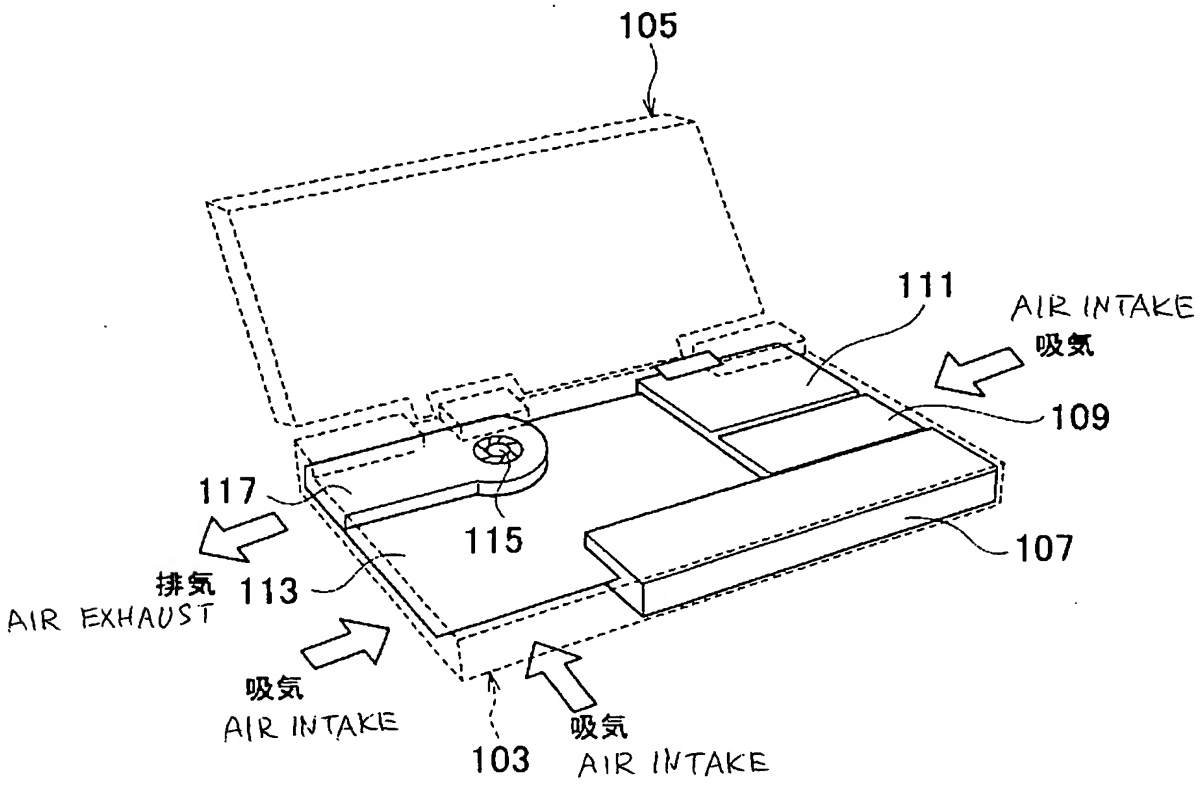
(B)



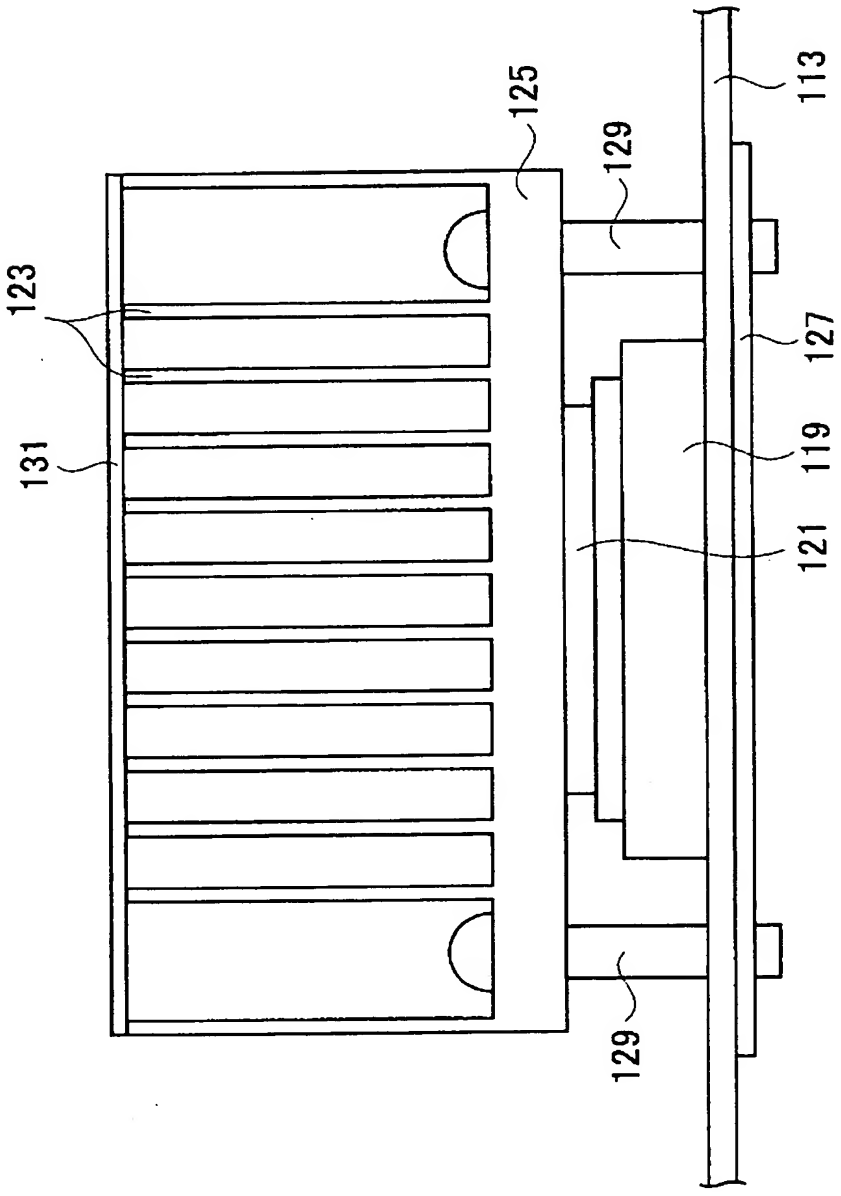
【図１３】 [FIG.13]



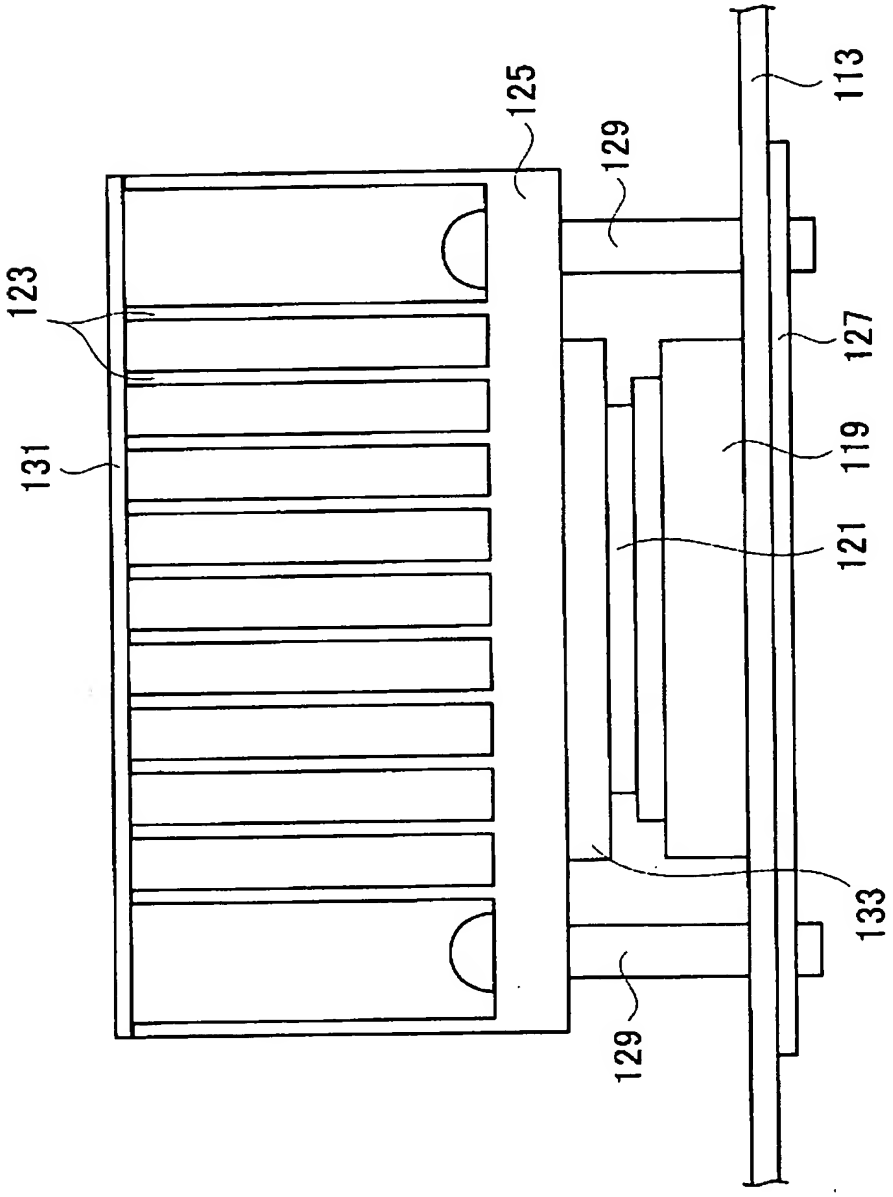
【図１４】 [FIG.14]



【図１５】〔FIG. 15〕

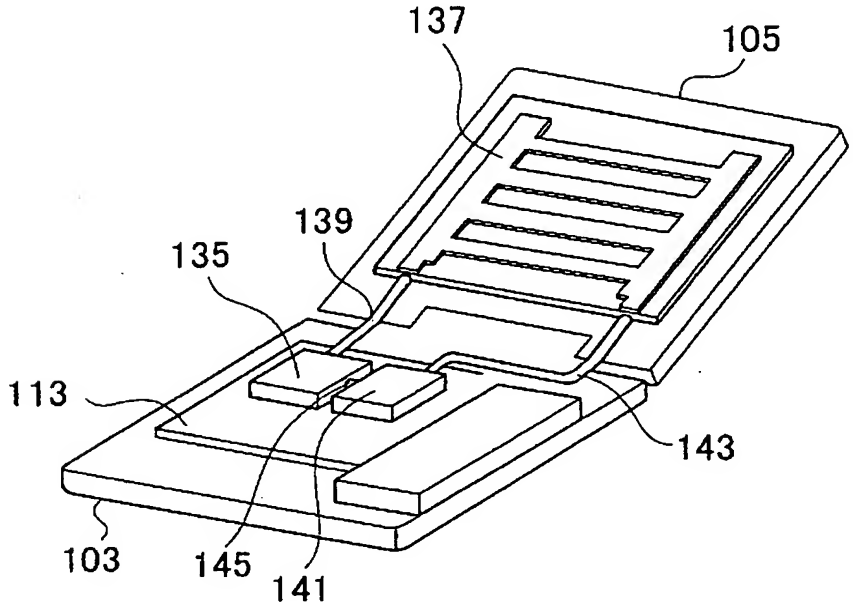


【図１６】[FIG.16]

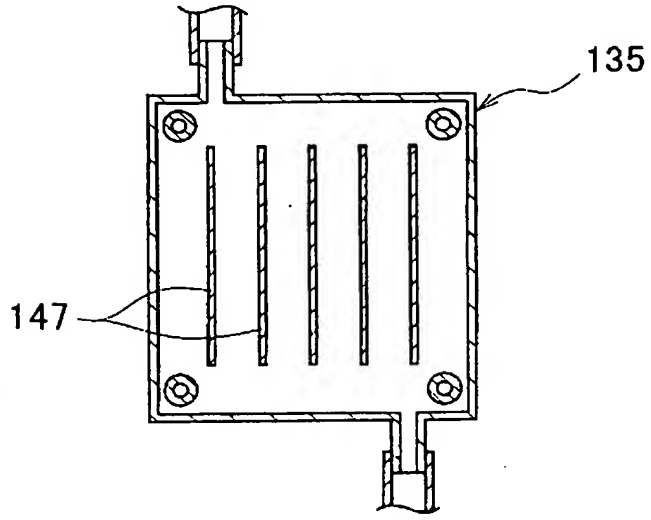


【図１７】 [FIG. 17]

(A)



(B)



[NAME OF THE DOCUMENT] ABSTRACT

[ABSTRACT]

[OBJECT] To provide a heat-producing-element cooling device and an electronic device using a Peltier element.

[SOLVING MEANS] A first flow channel through which a cooling medium for cooling the heat producing element is capable of passing to the heat producing element or an element cooling portion thermally linked with the heat producing element, a second flow channel through which the cooling medium after passing through the heat producing element or the element cooling portion and being heated is capable of passing, and active heat transport means comprising a heat absorption portion and a heat production portion are provided; the heat absorption portion is thermally linked with the first flow channel; and the heat production portion is thermally linked with the second flow channel.

[SELECTED FIGURE] FIG. 1